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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

SUMMARY OF PROGRESS
THROUGH **1981**

2.5
38
31

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

**SUMMARY OF PROGRESS
THROUGH 1981**

TRANSPORTATION RESEARCH BOARD

NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES—NATIONAL ACADEMY OF ENGINEERING

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NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Administrators, engineers, and many others in the transit industry are faced with a multitude of complex problems that range between local, regional, and national in their prevalence. How they might be solved is open to a variety of approaches; however, it is an established fact that a highly effective approach to problems of widespread commonality is one in which operating agencies join cooperatively to support, both in financial and other participatory respects, systematic research that is well designed, practically oriented, and carried out by highly competent researchers. As problems grow rapidly in number and escalate in complexity, the value of an orderly, high-quality cooperative endeavor likewise escalates.

Recognizing this in light of the many needs of the transit industry at large, the Urban Mass Transportation Administration, U.S. Department of Transportation, got under way in 1980 the National Cooperative Transit Research and Development Program (NCTRP). This is an objective national program that provides a mechanism by which UMTA's principal client groups across the nation can join cooperatively in an attempt to solve near-term public transportation problems through applied research, development, test, and evaluation. The client groups thereby have a channel through which they can directly influence a portion of UMTA's annual activities in transit technology development and deployment. Although present funding of the NCTRP is entirely from UMTA's Section 6 funds, the planning leading to inception of the Program envisioned that UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Academy of Sciences, a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services, (2) the American Public Transit Association responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials, State DOT officials, and officials from UMTA's Office of Technology Development and Deployment, and (3) the Urban Consortium for

Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

Research programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the National Academy of Sciences for acceptance and administration through the Transportation Research Board.

The Board operates within the National Research Council, which serves both the National Academy of Sciences and the National Academy of Engineering, and is uniquely suited for the administrative role because: it maintains an extensive committee structure from which authorities on any transportation subject may be drawn; it possesses the avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; it is recognized for its objectivity and understanding of modern research practices; its relationship to its parent organization is an insurance of objectivity; and it maintains a full-time staff of research specialists in transportation matters to take the findings of research directly to those who are in a position to use them.

Research projects addressing the problems referred from UMTA are defined by panels of experts established by the Board to provide technical guidance and counsel in the problem areas. The projects are advertised widely for proposals, and qualified agencies are selected on the basis of research plans offering the greatest probabilities of success. The research is carried out by these agencies under contract to the Academy, and administration and surveillance of the contract work are the responsibilities of the Academy and Board.

The needs for transit research are many, and the National Cooperative Transit Research and Development Program is a mechanism for deriving timely solutions for transportation problems of mutual concern to many responsible groups. In doing so, the Program operates complementary to, rather than as a substitute for or duplicate of, other transit research programs.

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SUMMARY OF PROGRESS

THROUGH 1981

INTRODUCTION

At the 1976 UMTA/APTA R&D Priorities Conference there was consensus among spokesmen for the Office of Management and Budget, Congress, and the transit industry that the Urban Mass Transportation Administration, U.S. Department of Transportation, should undertake a cooperative program of R&D to attack near-term problems in transit operations and equipment. This was the genesis of the National Cooperative Transit Research and Development Program (NCTRP) that got under way in November 1980 under the authority of Section 6(a) of the UMTA Act of 1964, as amended (49 U.S.C. 1605(a)). Thereby provided is a mechanism for addressing problems that impede operational effectiveness or productivity, but are not of the character to justify a centrally managed, Federally directed, R&D effort. This mechanism not only enables UMTA's principal client groups to join cooperatively in attempts to resolve near-term public transportation problems through applied research, development, testing, and evaluation, but it also provides them with a channel through which they can directly influence a limited portion of UMTA's annual activities in transit technology development and deployment. Consequently, the NCTRP's overall objectives are:

- To identify problems commonly agreed to be in need of R&D investigation and to establish a priority ordering among them.
- To provide an opportunity for many constituencies, including transit operators and local government officials, to identify problems and participate in developing solutions to them.
- To improve communication and technical information exchange.
- To provide a means of addressing near-term transit problems without requiring detailed, formal involvement of the Federal Government in the execution of R&D projects designed to provide solutions.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Academy of Sciences NAS, a private, nonprofit institution, as the Primary Technical Contractor (PTC) responsible for administrative and technical services, (2) the American Public Transit Association responsible for operation of a Technical Steering Group (TSG) comprised of representatives of

transit operators, local government officials, State DOT officials, and officials from UMTA's Office of Technology Development and Deployment, and (3) the Urban Consortium for Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

Research programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the National Academy of Sciences for acceptance and administration through the Transportation Research Board (refer to Figures 1 and 2). There, they are assigned to seven broad research fields under which panels or committees of experts are organized to deal with research in specific problem areas under the broad fields. They analyze the problems, outline particular projects and their objectives, and then prepare research project statements by which a wide solicitation is made for proposals from qualified private and public research agencies. They review the proposals, recommend contract awards on the basis of research plans offering the greatest probability of success, and provide counsel to the NCTRP staff responsible for surveillance of work under the research contracts. Finally, they review final reports for acceptability, decide if the reports evidence reasonable accomplishment by the agencies of the projects' research plans, and assist staff in determining the warrants for publishing the reports in a regular NCTRP series and distributing them through standing Board processes.

Panel membership is reported in the TRB Directory and includes persons from state and federal agencies, the UMTA client groups, universities, national associations, institutions with related interests, industry and other agencies. Members are appointed as individuals possessing expertise in specialized areas and not as representatives of the organizations by which they are employed. Because rarely is it possible to acquire members with the required knowledge and judgment who do not have technical biases, concerted attention is given to maintaining a balance of such biases. However, prejudicial biases, along with organizational and personal biases, are scrupulously avoided.

The Board's authority for administration of the Program rests with its Executive Committee from which is drawn the Subcommittee for the NCTRP, the body providing

counsel on all matters relating to policies and procedures for the planning and administration of the Program. The day-to-day activities are carried out by professional staff assigned by the Board. Projects engineers with broad experience in transportation research are responsible for administrative and technical surveillance of the contracts. In addition to reviewing quarterly progress reports and monthly progress schedules and maintaining telephone contacts, each engineer regularly visits his assigned projects throughout their contract periods. He discusses with each principal investigator the project's status to learn if the research is being pursued in line with the approved research plan. If necessary, frequent meetings involving the staff, panel, and agency personnel are held to review project

progress and provide guidance for continuing work. Finally, the projects engineer and the panel evaluate the completed research to determine the degree of technical compliance with the contract and the acceptability of the final report to the Board and the Academy.

The research findings are published in either of two regular NCTRP report series, and copies are formally distributed through the Transportation Research Board's selective distribution system.

Although research in the NCTRP is presently sponsored by UMTA, the administrative mechanism is applicable to other agencies' programs as well. However, the following description of how research is administered applies specifically to research sponsored by the UMTA.

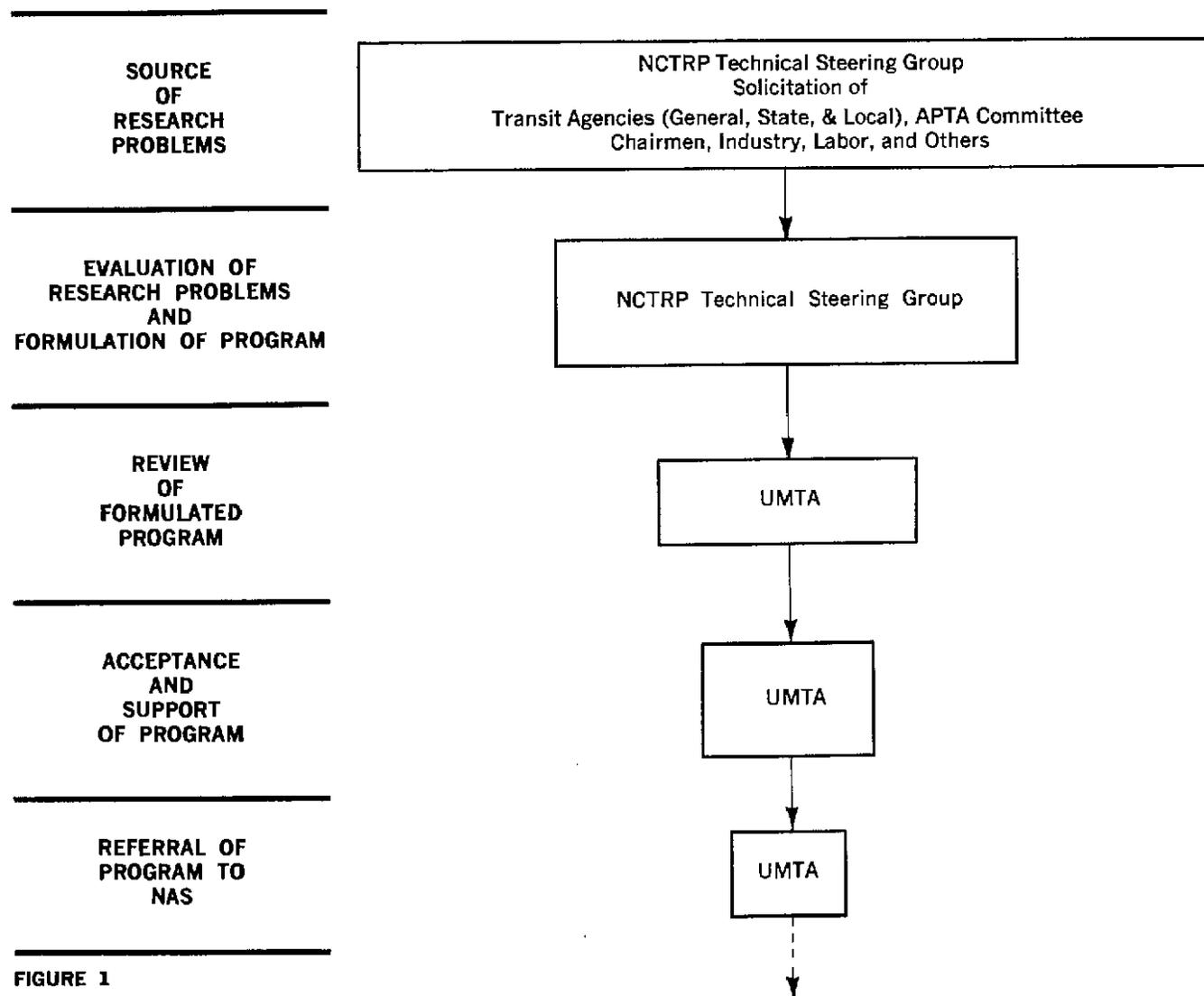


FIGURE 1

Flow diagram for each program from initiation to referral by UMTA to the National Academy of Sciences

PROGRAMS AND FINANCING

The first research program, that for FY 1980, was received on November 7, 1980, and consisted of ten problems ranging in funding from \$40,000 to \$300,000. Two of the problems were picked up by UMTA for in-house research; two others, each at \$75,000, were designated for syntheses by TRB. The remaining six were scheduled for contract research.

On October 7, 1981, the FY 1981 program was formulated by the Technical Steering Group, and it consisted of eight problems ranging in funding from \$30,000 to \$300,000. Two of the problems, each at 30,000, are designated for syntheses by TRB. The remaining six are scheduled for contract research.

Funding to support FY '80 research to the extent of \$990,000 and FY '81 research at \$985,000 originated with UMTA's Section 6 funds for R&D activity. That for FY '80 consisted of an aggregation of funds earmarked for fiscal years 1978, 1979, and 1980. Although initiation of the NCTRP was accomplished solely with UMTA funds, the planning leading to inception of the Program envisioned that, given the multitude of problems facing them, UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a larger number of problems each year. Presently, the funds available to the NCTRP are sufficient to address but a fraction of the total need represented by problem submittals to the Technical Steering Group.

HOW THE NCTRP IS ORGANIZED TO ADMINISTER RESEARCH PROGRAMS

In line with the Board's responsibility for administering the NCTRP, a TRB Executive Committee Subcommittee for the NCTRP considers all matters relating to policies and procedures required for the planning and administration of the Program. Members of the Executive Committee make up this committee.

In addition, the Board has established seven broad research fields under which project panels are organized to deal with research in specific problem areas under the broad fields (refer to Figure 3). For example, in the broad subject field of Operations, each project falling within the more specific subject area of Energy Efficiency—area 54—is assigned a panel comprised of outstanding individuals who are knowledgeable in the specifics of the particular project and who are looked to for technical guidance while research is in progress. Those projects that do not conveniently fit under one of the first six general fields are assigned to the seventh one, Special Projects.

Members of the project panels do not act as consultants or advisors to project investigators. Some 55 individuals serve without compensation on these project panels, and their total yearly contribution to the Program is an impressive and laudatory effort by volunteer professionals. Members are drawn from the agencies given in Table 1, and they come from 16 States and the District of Columbia. Employees of transit operating agencies presently con-

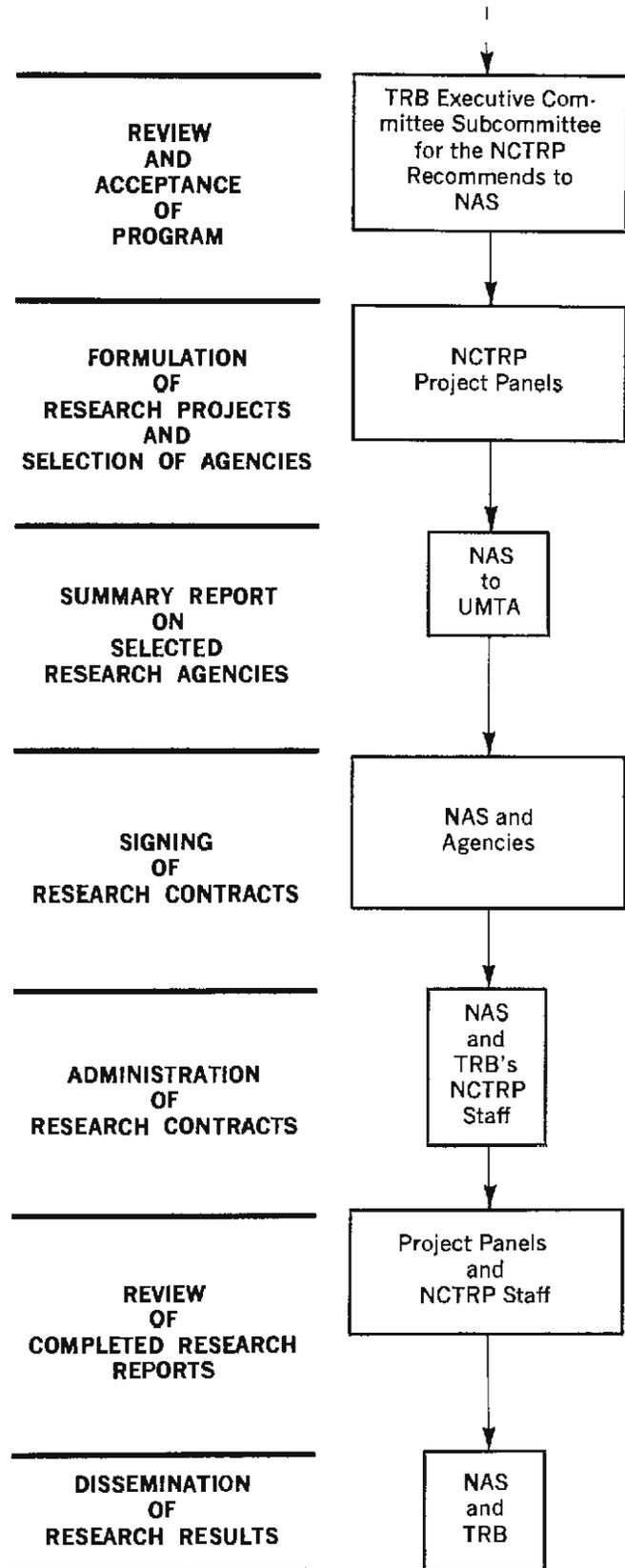
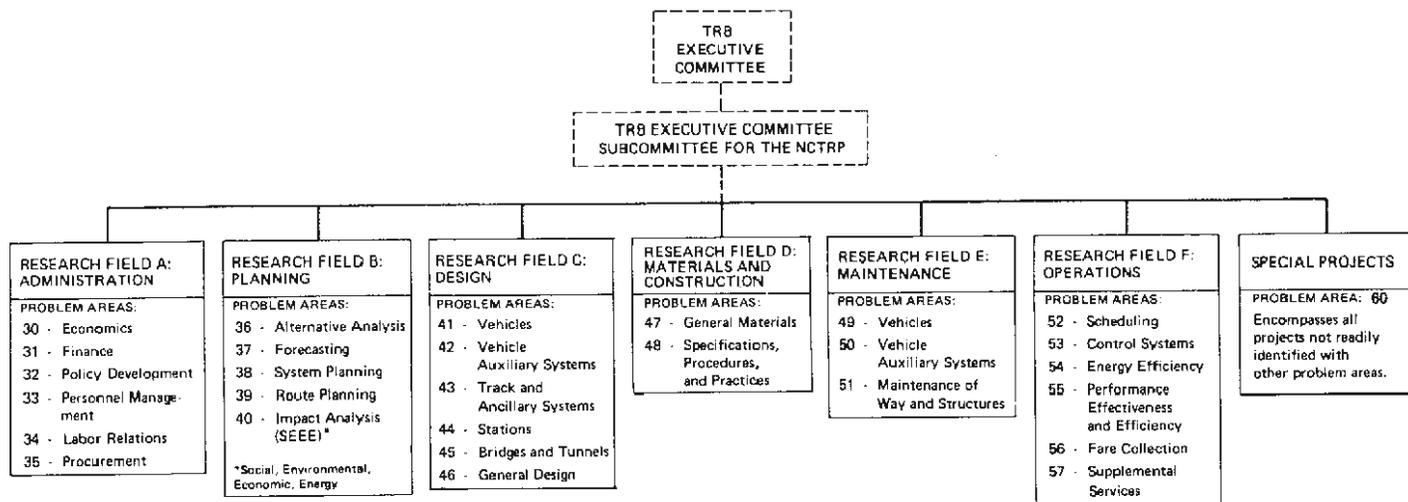


FIGURE 2

Flow Diagram for Each Program After Referral to the National Academy of Sciences

NCTRP RESEARCH FIELDS AND AREAS



stitute 36 percent of panel membership. The duties and responsibilities of the membership include:

- Developing an operation plan geared to reaching the major problem area objective, including estimates of total cost and time to achieve the objectives.
- Drafting definite statements of objectives for projects within the problem area and within the funds allotted.
- Reviewing research proposals and making recommendations regarding selection of research agencies.
- Reviewing research progress.
- Providing guidance regarding technical aspects of the research.
- Reviewing and evaluating project reports as to the accomplishment of objectives and suitability for publication.
- Making recommendations as to whether or not studies of problems included in prior fiscal year programs should be continued.

Following the NCTRP staff review made after program referral to the Academy, the recommended program is referred to the TRB Executive Committee Subcommittee for the NCTRP for comments as to the critical need for the research, the availability of other suitable sponsors, and whether or not the research items are appropriate to be identified with the Academy. Unacceptable problems are returned by the Academy to UMTA with the reason for rejection and, when appropriate, with a recommendation for disposition.

HOW THE PROJECTS ARE PLACED UNDER CONTRACT

It is important to note that the NCTRP is not in the business of awarding grants for basic research. Rather, the Program calls for contract research with specific objectives that, if achieved, will result in solutions that are practical and readily usable. As the NCTRP officially gets each year's program under way, the project panels

meet to write research project statements based on the research problems referred by UMTA.

These statements are then sent automatically to a mailing list of more than 3,000 interested individuals and research agencies. Because of deadlines the NCTRP must meet, proposals must be submitted according to fixed deadlines, and extensions simply cannot be granted.

In line with this process, submittals from 68 agencies for the first program year (FY '80) ranged from 8 to 22 per project, the average rate of return per project being 13 (refer to Table 2). Nine agencies submitted two proposals (refer to Table 3) each.

The types of agencies responding with proposals for the FY '80 program are given in Table 4. The TRB, which, in certain instances, conducts NCTRP research directly in its Special Projects Division is also included. The six

TABLE 1
 DISTRIBUTION OF PROJECT PANEL
 COMMITTEE MEMBERSHIP WITH
 RESPECT TO AFFILIATION

AFFILIATION	NO. OF MEMBERS	POSITIONS INVOLVED
Transit Systems	20	20
State DOTs and Other Local Governmental Agencies	8	8
Urban Mass Transit Administration	6	6
Other Federal Agencies	2	2
Educational Institutions	5	5
Research Institutes	2	2
Industry, Consultants, and Trade Associations	5	5
Professional Societies and Service Organizations	2	2
TRB Liaison Representatives	5	5
All	55	55

TABLE 2
NUMBER OF PROPOSALS SUBMITTED

ITEM	1981
No. of projects advertised	6
Proposals submitted	77
Proposals rec'd per project (ave.)	13

projects making up this program are given in Table 5, and the types of agencies selected to carry out the projects are given in Table 6.

The opportunity to propose is open to anyone possessing extensive, demonstrated capability and experience in the problem areas in question; never are projects developed with the intent that they go to particular agencies. Because the projects are seeking practical remedies for pressing operational problems, it is expected that only the highest level of agency capability will be applied in meeting the commitments of the proposal—capability cannot be developed at project expense. Consonant with the goal of providing practical, readily usable solutions to pressing problems, there are fairly stringent specifications for proposals and agency attributes that are acceptable to the mission-oriented nature of the NCTRP.

The staff and panel members evaluate all proposals in a uniform manner, with primary consideration given to:

- The understanding of the problem and the merit of the research plan and approach.
- The experiment design and the promise of fulfilling the objectives of the project statement.
- The qualifications of the principal investigator(s).
- The adequacy of the facilities.

The proposed budget is not one of the primary factors because the funds available for research are given in the project statement. The budget does not enter the evaluation process leading to agency selection, except when specific items are reviewed to better determine manpower allocations. When the proposed cost exceeds the funds available, the proposal is rejected on receipt.

A panel meeting is held to select an agency, and a review is made of all known aspects of agency performance on other research projects under NCTRP or elsewhere. The successful proposals are retained by the panel members for

TABLE 3
NUMBER OF AGENCIES SUBMITTING
ONE OR MORE RESEARCH PROPOSALS

NO. OF PROPOSALS SUBMITTED	NUMBER OF AGENCIES SUBMITTING PROPOSALS
	1981
1	59
2	9
All	68

TABLE 4
TYPES OF AGENCIES
SUBMITTING PROPOSALS

TYPE OF AGENCY	NO. OF AGENCIES SUBMITTING
	1981
Educational institutions	20
Research institutes	7
Industry, consultants, and trade associations	40
Professional societies and service organizations	0
State DOTs and other governmental agencies	1
All	68
No. of projects advertised	13

use in monitoring the research. Proposals are considered to be privileged, and the information in them is not released outside of the Academy unless explicit approval is obtained from the agency. Policy also holds that panel notes, deliberations, etc., are privileged.

Following the selection meeting, a summary report on the recommended research agencies is sent to UMTA, and contract negotiations follow in due course, as does contract execution and commencement of research. Again, it should be emphasized that the NCTRP is a program of *contract* research—it does not operate on a grant basis. Further, proposals can be received only in response to advertised project statements, as the funds available each year to the Program are earmarked in their entirety for research problems specified by the sponsor—UMTA.

The policy of the NCTRP is to provide a debriefing to unsuccessful proposers. The initiative for obtaining a debriefing lies with the proposers and must be requested in writing. The debriefing is intended to indicate to the proposers the technical areas in which their proposals were judged weak and deficient and how the weaknesses or deficiencies were factors in their not having been selected. All debriefings are conducted in a scrupulously fair, objective, and impartial manner, and the information given the unsuccessful proposers is absolutely factual and consistent with the evaluations by the NCTRP panels. The factors constituting the basis for selection of the successful agency are identified, but the debriefing does not include a point-by-point comparison of all the elements considered in the evaluation criteria. Neither is there any revelation of confidential business information, trade secrets, techniques, or processes of the other proposers, nor is there any indication of the relative merits or technical standings of the unsuccessful proposers.

The Academy's research contract is either:

- Cost-Reimbursement (CR)
- Cost-Reimbursement Plus Fixed Fee (CRPFF)
- Fixed Price (FP) (used only rarely)

TABLE 5
PROJECTS FOR FY '81 SUMMARY OF STATUS THROUGH DECEMBER 31, 1981

PROJECT		RESEARCH AGENCY	CONTRAC AMOUNT CONTRAC COST (\$)
NO.	TITLE		
AREA 30: ECONOMICS			
30-1	Comparative Study of Small Buses	—	\$300,000
AREA 31: ADMINISTRATION—FINANCE			
31-1	The Impacts of Federal Grant Requirements on Transit Agencies	Booz-Allen	50,000
AREA 33: ADMINISTRATION—PERSONNEL MANAGEMENT			
33-1	Transit Bus Operator Selection and Training for Dealing with Stress	GAMS Inc.	150,000
33-2	Development of Programs for Job Enrichment in the Transit Industry	—	100,000
AREA 36: PLANNING—ALTERNATIVE ANALYSIS			
36-1	Improving Decision-Making for Major Urban Transit Investments	Systems Des. Concept	150,000
AREA 38: PLANNING—SYSTEM PLANNING			
38-1	National Transit Computer Software Directory	—	100,000
AREA 39: PLANNING—ROUTE PLANNING			
39-1	Study of Automatic Passenger Counting System	—	175,000
AREA 40: PLANNING—IMPACT ANALYSIS			
40-1	Development of a National Standard Analysis Process for Cost/Benefit of Transit Systems	—	150,000
AREA 43: DESIGN—TRACK AND ANCILLARY SYSTEMS			
43-1	Detection of Low Current Short Circuits	—	100,000
AREA 47: MATERIALS AND CONSTRUCTION—GENERAL MATERIALS			
47-1	Improved Service Life of Urban Transit Coach Brakes	Battelle Mem Inst	300,000
AREA 54: OPERATIONS—ENERGY EFFICIENCY			
54-1	Improve Transit Bus Energy Efficiency and Productivity	Booz-Allen	39,993
54-2	Energy Management of Electric Rail Transit Systems	Carnegie-Mellon	135,115
AREA 60: SPECIAL PROJECTS			
60-1	Synthesis of Information Related to Transit Problems	TRB	210,000
TS-1:	Cleaning Equipment and Procedures for Transit Buses	ATE Mgmt	17,160
TS-2:	Priority Treatment for Buses on Urban Streets	PAWA	19,716
TS-3:	Cost-Benefit Analysis of Fuel Additives and Alternative Fuel Grades	—	30,000
TS-4:	Standard for Allocation of Time for Maintenance Workers	—	30,000

* Continuing activity supported in FY '80 and FY '81 at amount shown.

	COMPLETION DATE	PROJECT STATUS (for details, see latest Summary of Progress)	PROJECT NO.
	—	Project details will be developed in March 1982	30-1
'81	8/18/82	Research in progress	31-1
'81	10/14/83	Research in progress	33-1
	—	Project details will be developed in March 1982	33-2
'81	2/1/83	Research in progress	36-1
	—	Project details will be developed in March 1982	38-1
	—	Project details will be developed in March 1982	39-1
	—	Project details will be developed in March 1982	40-1
	—	Project details will be developed in March 1982	43-1
'81	11/30/83	Research in progress	47-1
'81	4/30/82	Research in progress	54-1
'81	12/31/82	Research in progress	54-2
'80	*	Research in progress	60-1
'81	12/31/81	Report in editorial and publication process	(TS-1) 60-1
'81	12/31/81	Report in editorial and publication process	(TS-2) 60-1
	—	Project details will be developed in early 1982	(TS-3) 60-1
	—	Project details will be developed in early 1982	(TS-4) 60-1

TABLE 6
AGENCY DISTRIBUTION OF FY '80 PROJECTS

TYPE OF AGENCY	PROJECTS AND CONTINUATIONS	
	NO.	%
Educational institutions	1	17
Research institutes	1	17
Industry, consultants, and trade associations	4	66
Professional societies and service organizations	0	0
State DOTs and other governmental agencies	0	0
All	6	100

The research agency's proposal is made a part of the contract with the Academy. Thus, in addition to the specific research objectives outlined in the contract, the research agency's cost estimates are also recognized as being part of the agreement. However, the principal investigator does have flexibility in conducting the research, if it is consistent with the general scheme of the proposal.

KEEPING TRACK OF RESEARCH IN PROGRESS

A professional staff is assigned to NCTRP by the Board. Currently, five projects engineers with wide-ranging expertise are responsible for administrative and technical surveillance of the contracts. In addition to reviewing quarterly progress reports and monthly progress schedules, and maintaining telephone contacts, each engineer visits his assigned research agencies throughout their contract periods. He discusses with each principal investigator his project's status to learn if the research is being pursued in line with the approved research plan. Finally, the engineer and cognizant project panel evaluate the completed research to determine the degree of technical compliance with the contract.

SYSTEMATIC PLANNING FOR GETTING RESEARCH RESULTS FROM NCTRP PROJECTS INTO PRACTICE

Promoting Useful Results

Previous narrative substantiates the fact that many activities take place between initiation of research programs and execution of research contracts. Many additional ones take place before formal publication of the final report is realized. At the milestones of the process network reflecting all activities, NCTRP concentrates on the opportunities to increase the odds for acquiring useful research results and to increase the probability that useful results will find their way into practice more quickly. Beyond the sponsor's first weighting of the odds by setting the goals for a program of applied research dedicated to solving pressing operational problems, the NCTRP tries to further weight the odds favorably by:

- Establishing the agency and personnel qualifications that are mandatory if the goals are to be achieved. Emphasis is placed on the importance of a record of successful past performance in endeavors similar to those to be undertaken. Further, it is also stipulated that proposals are not acceptable if they do not contain specific statements as to how the contemplated results can be used to improve practice.

- Utilizing persons who are not only experts in the particular problems area but who also have a complete understanding of the needs of the practitioners to define the research problem and its objectives in the form of a precise project statement on which fully responsive research proposals can be based. Experts drawn from transit agencies play a major role in this task.

- Exercising extreme care in the process of selecting research agencies to ensure not only that the proposed research plan is the best possible in addressing the specifics of the objectives but that it also culminates in the best promise for providing the practitioner with a product that is both usable and readily implementable.

- Establishing—on the basis of staff and project panel review of and suggested modifications to the research plan—a clear meeting of the minds as to what specifically is expected from the research and the personnel carrying it out in order to meet the needs of practitioners.

- Acquiring an amplified research plan that is intended to detail comprehensively the approved research plan and to include a specific schedule of events for the major tasks. This document is used by the staff in the day-to-day surveillance of the project's progress and by the project panel as required.

- Carrying out project surveillance sufficient to keeping the research in line with the approved research plan, constantly keeping the researchers aware of the needs of practitioners, and insuring that all project developments through final reporting center around these needs.

- Requiring research reports in a format that is designed specifically to ease the burden of the busy practitioners in assimilating what has resulted from the research and how it can be used. Different treatment is given to the material that would be of interest to other researchers.

NCTRP Reporting of Research Results

In an applied research program such as the NCTRP, the sponsor rightfully expects not only results that are accurate but also findings that can be readily put into practice. This means that the final research reports must be presented in language understandable to practitioners and in such format as to permit easy assimilation. Too many of today's research reports are frequently so clouded by obscure language and format that the reader must spend precious time and effort in translating them into concise and readily usable working documents.

Research agencies for the NCTRP are required to report their results in a form that succinctly summarizes the findings and likewise informs the reader of the application of

the findings. These objectives are accomplished through a "Summary of Findings," and a chapter on "Interpretation, Appraisal, and Application of Results." The detailed research techniques and analyses in which a researcher would be interested are presented in appendices and do not have to be labored through to extract the findings. The Program specifies style and organization of all reports to guide the researcher in his writing to provide a document of maximum use by the sponsors and others.

Prior to publication, extraordinary measures are taken to ensure that useful research results are made immediately available to the appropriate personnel. One means consists of forwarding copies of the research agency drafts of final reports. According to the urgency of the particular circumstances, these drafts may be either uncorrected or corrected on the basis of an acceptance review. Several copies of unedited drafts of the agency reports are retained until formal publication in either of the two regular NCTRP series (Reports or Syntheses of Transit Practice) and are available, on a loan basis, to others having an interest in the research. Once published in their entirety, the drafts are destroyed.

After publication in the NCTRP series, each report or synthesis is distributed immediately through the Transportation Research Board's selective distribution system. Copies go automatically to about 100 libraries, Board transit representatives, educational institutions, liaison representatives, appropriate panels and committees of the Board, and individual members who have selected publications in the particular subject area of the report. As a further means of disseminating the research reports, announcements of their availability are made to the trade press. Each of these reports contains a staff-prepared foreword that directs the attention of the busy reader to the persons who would be most interested in the results and, also, to how the results fit into present knowledge and practice. Also, during the conduct of the work, periodic progress reports are prepared by the staff and sent to UMTA as a measure of providing a current awareness of on-going work. In addition, the Board's Technical Activities Staff personnel follow the progress of the work throughout its conduct and consequently are able, in their activities, to discuss application of the research results with those best able to use them. Research findings not published in the NCTRP series are stored on microfiche by the Academy. On an interim basis, the findings are sometimes reported in a *Research Results Digest*, described next.

The *NCTRP Research Results Digest* series—flyers published at frequent intervals—is a means for providing practitioners with an early awareness of the research results emanating from NCTRP projects. By making results known as they are developed and prior to publication of the final reports in the regular NCTRP series, it is hoped that their early use in practice will be encouraged. For the most part, each Digest is intended to be very brief in summarizing specific findings—they do not deal with research methodology—and require the reader to expend very little time in determining how the research results may be of use to him. The basic format is couched in terms of the problem and the solution to it, the findings, and applications. Practitioners should find them of direct assistance in serving the intermediary, or interpre-

tive, position between research and operating personnel, for each Digest speaks directly to the vital factors of:

- Whether the research stands alone or whether it has to be combined with results from other research in order to be useful.
- Whether the results are defined explicitly enough to permit direct application to practice.
- Whether the results have to be translated into the working tools with which the practitioner is familiar.
- Whether the research findings have been evaluated sufficiently to make some reasonable determination of the probability of their success when applied to practice.

IMPLEMENTING RESEARCH RESULTS

Emphasis has been given in the foregoing to the devices employed to obtain solutions that are directly applicable to practice. Because the NCTRP process does not include an implementation activity, the initiatives for incorporating the solutions in practice must be taken by the UMTA and transit agencies. To this end, the Program's final concentration is on the reporting of research findings in one or more of the variety of publications described earlier and, as will be done in future annual reports, providing whatever details are available on the experiences of the States and transit agencies in using the products from NCTRP research. With this objective, the Program will be grateful for any information on actual application of results and associated benefits. Because the research addresses critical, national problems, the assumption is that documented use and payoff to any one agency should attract others to give the results a try in whatever degree they see fit. Only if the results get around and are used can it be said that UMTA truly is capitalizing on its investment. Otherwise, projects that were highly successful might just as well have been failures; the end result is the same—the money will have been spent in vain.

SUMMARY

The National Cooperative Transit Research and Development Program is a unique contract research effort designed to respond quickly and efficiently to the needs of UMTA and the transit industry through solution of near-term public transportation problems. Although the Transportation Research Board administers the Program, the research content is solely the prerogative of the Urban Mass Transportation Administration. The Program is one of applied (rather than basic) research, and every possible effort is made to help administrators and engineers put the findings to early use. Program policy ensures maximum exposure of the research while in progress in the hope that research results will, in fact, more quickly find their way into practice in the form of policies, procedures, specifications, and standards of the operating agencies.

PROGRESS BY PROJECT

Only those areas are listed in which there are active projects. For a complete list of project areas, refer to Figure 3.

AREA 30: ECONOMICS

Project 30-1 FY '81

Comparative Study of Small Buses

Research Agency:
Principal Invest.: To Be Determined
Effective Date:
Completion Date:
Funds: \$300,000

Project details will be developed in March 1982.

AREA 31: FINANCE

Project 31-1 FY '80

The Impacts of Federal Grant Requirements on Transit Agencies

Research Agency: Booz, Allen & Hamilton, Inc.
Principal Invest.: Subhash R. Mundle
Effective Date: November 30, 1981
Completion Date: August 18, 1982
Funds: \$50,000

As the federal transit program has grown, this growth has been accompanied by a proliferation of federally imposed requirements. The costs and effects of grant requirements are causing increasing concern to transit agencies. A Section 3 grant application for a new bus purchase requires approximately 21 exhibits to comply with UMTA requirements. Additionally, several annual submissions are required if the grant approval process takes more than one year.

Such requirements have forced many transit operators to allocate scarce resources to federally required procedural work. The costs of compliance may include (1) inflationary cost escalations, (2) allocation of funds to administrative detail, (3) project delays, (4) revisions of project scope, (5) reductions in management flexibility, and (6) increased capital costs.

There is a need to quantify the impacts of federal requirements on the capacity of a transit system to (1) comply and (2) serve effectively the intent of the legislation. Furthermore, there is a need to develop recommendations to improve the grant application process.

Presently available funds are sufficient to address but a portion of the entire problem; therefore, research needed beyond that described below will depend on provision of additional resources from future years.

The general objective of this study is to determine the costs and effects of federal legislation, regulations, UMTA

circulars, administrative letters and formal administrative guidelines for the Section 3 capital grant application process and to make recommendations for its improvement. The study results are anticipated to be useful to (1) transit agencies in their decision to apply for federal grants, (2) legislators drafting legislation, and (3) the Urban Mass Transportation Administration in amending requirements. In recommending improvements consideration will be given to the intent of legislation, regulations, circulars, letters, and guidelines.

Because of the limitation on available funds, the research specifically excludes consideration of Section 13(c) and 504 requirements. Additionally, the research will not consider Section 5 capital and operating grants; applicability to fixed guideway systems; project management requirements for approved grants; and applicability to specialized transit services.

Toward this general objective, the following tasks are considered essential but not limiting.

Task 1—Develop scenario(s) that will describe medium-sized transit agencies qualifying for and applying for an increase in size of their bus fleet by 25 percent. Such scenario(s) should identify the requirements that the agency would have to meet in order to be eligible for funding under UMTA Section 3. Scenario elements should include but not necessarily be limited to (1) project justification and planning (SRTP-TIP), (2) grant application and documentation, (3) bus maintenance requirements, (4) human resource regulations, and (5) public hearing requirements.

Task 2—Determine, on the basis of real experience, the costs and effects to the transit agency of the requirements in the scenario(s) outlined in Task 1.

Task 3—Determine how the results of Tasks 1 and 2 can be applied to larger and smaller agencies.

Task 4—Compare the actual results of the various requirements with the procedural intent of those requirements.

Task 5—Develop recommendations: (a) procedural reform to expedite UMTA's obligation of funds, and (b) strategies to reduce costs to transit agencies.

AREA 33: PERSONNEL MANAGEMENT

Project 33-1 FY '80

Transit Bus Operator Selection and Training for Dealing With Stress

Research Agency: Group Associated Management Services, Inc.
Principal Invest.: Dr. Brownlee Elliott
Effective Date: October 15, 1981
Completion Date: October 14, 1983
Funds: \$150,000

Some bus operators possessing the basic skills to operate the vehicle may still experience difficulties in performing

their job satisfactorily because of inability to cope effectively with the public. Use of all possible training and disciplinary action does not help when the individual hired does not have the psychological strengths necessary to deal effectively with continuous public contact, and the resultant stress may lead to more workers' compensation claims for nonvisible physical injury (i.e., heart and psychological problems) as well as to more accidents, absenteeism, and personnel turnover.

Various selection and training methods are currently being used by individual transit agencies. Some of these methods have been developed specifically for application in the transit industry, some have evolved from practice within individual agencies, and others represent modifications to methods originally developed for agencies outside of the transit industry. At present, however, no single method of selecting or training bus operators from the viewpoint of their ability to deal with stress is considered to be generally acceptable for wide application by transit agencies. To ensure that methods have general applicability, the range of needs and capabilities of different size transit agencies, regional differences, and the makeup of the bus operator population (i.e., male/female and minorities) must be fully considered.

The objective of this research is to provide an evaluative device or questionnaire for use as part of the bus-driver-selection process that will validly indicate the applicant's susceptibility to stress which is likely to affect job performance. The research will also provide two training modules: one designed to help newly hired operators anticipate and deal with typical stressful situations, and one designed to help supervisors recognize stress symptoms displayed by operators and provide guidance on appropriate courses of action.

Reference literature and existing training programs will be reviewed to identify the various environmental, physiological, and psychological factors commonly used in stress analysis. From this review, a preliminary set of factors and characteristics relevant to the bus operators' job will be prepared. This preliminary set will be reviewed and evaluated by managers, operators, and labor representatives from selected transit agencies for suggested additions and deletions. The sample to be selected will include a minimum of one large agency (more than 500 buses), two medium agencies (100 to 500 buses), and three small agencies (less than 100 buses).

Existing operator-selection-test mechanisms will be evaluated for general applicability in measuring an individual's tolerance for stress, and then either an existing device will be modified or a new test device will be developed. The resulting device will bring together current efforts dealing with the effects of stress, will have wide applicability in the transit industry, and will be primarily aimed at screening new applicants. The device will treat stress factors individually and in groups such as passenger contact, environment, management/union/employee relations, personal problems, and equipment. The device will be field tested by operators from selected transit agencies.

Two sample training modules will also be prepared: one for newly hired operator training (and perhaps for volun-

tary retraining) and one for supervisor training. The primary focus of the new operator training will be to alert the driver to typical stress-causing situations and to provide specific guidance on how to cope with each situation. Typical situations include (1) passenger contacts, e.g., fights on the bus; (2) environmental factors, e.g., bad weather; (3) management/union/employee relations; (4) personal problems, and (5) equipment. The supervisor's training module will focus on the recognition of stress symptoms and tendencies (resulting from personal or job-related causes) and on the identification of appropriate courses of action. Both modules will be adaptable by an individual transit agency so that through property-specific modifications they can be made part of existing training programs.

A listing will be provided of pertinent data and resources (films, videotapes, surveys, models, books, papers, etc.) identifying concomitant costs, sources, and transit agencies that are using such methods for selection and stress management training of bus operators and supervisors.

Project 33-2 FY '81

Development of Programs for Job Enrichment in the Transit Industry

Research Agency: To Be Determined
Principal Invest.:
Effective Date:
Completion Date:
Funds: \$100,000

Project details will be developed in March 1982.

AREA 36: ALTERNATIVE ANALYSIS

Project 36-1 FY '80

Improving Decision-Making for Major Urban Transit Investments

Research Agency: System Design Concepts, Inc.
Principal Invest.: Joseph R. Stowers
Effective Date: November 2, 1981
Completion Date: February 1, 1983
Funds: \$150,000

The environment for transportation planning and investment decisions is in a period of dramatic change. Fiscal constraints, a possible reorientation of federal transportation policies, and an increasing reliance on local commitment and decision-making are all likely to influence significantly the future of transportation in urban areas. Even with these pressures, however, urban areas will still be facing decisions on major investments in transit systems. Thus, there will be a need in future years for a planning and analysis process which examines major transportation options and which informs decision-makers so that most cost-effective investment decisions can be effected.

Since 1975, the Urban Mass Transportation Administration has required, as a condition for federal funding sup-

port, a structured process termed alternatives analysis for proposed major investments in urban mass transit facilities. This process is used to identify priority corridors for possible major investments and to assess the cost-effectiveness of these investments in comparison to less costly transit improvements. Information generated in the process is used both by federal officials in administering a discretionary capital grant program and by state and local officials in determining priorities and identifying needed improvements in mass transportation services. Three important decision points occur within the UMTA major transit investment planning process. First, appropriate local officials identify the corridor(s) where major investments appear to be most needed. Second, local and federal officials agree on a small set of investment alternatives that encompass a reasonably broad range of options. Finally, local, state, and federal officials agree on one (or more) of these alternatives for advancement into preliminary engineering.

Since the advent of the alternatives analysis requirement, a significant number of urban areas have been involved in some aspect of the process. Concerns have been expressed with the process. For example, there is uncertainty regarding both the effect on the timing of transit investment decisions and the use of information in the federal review process and in local decision-making. Although adjustments to the process have been made to enhance its usefulness in local, state, and federal decision-making, no comprehensive assessment has been made of the degree to which the analytical requirements have provided appropriate information at key decision points.

There is a need to evaluate past experience with alternatives analysis and to recommend improvements in the process that will result in more effective local, state, and federal decision-making. Such an assessment would be useful, for example, in identifying points where decision-makers have not had complete information, where the process has constrained appropriate decisions, or where significant efforts are invested in the development of information that is not used in decision-making. Although it is unclear what direction federal policy will take in regard to alternatives analysis, the need for some form of alternatives analysis for such investments will continue.

The general objective of this research is to assess the federal, state, and local decision-making process for major urban mass transportation investments by evaluating recent alternatives analysis experiences. The purpose of the assessment is to identify potential improvements in policy, procedures, and use of technical information; and to formulate planning procedures recommendations for use by federal, state, and local agencies. Such improvements would be in terms of time, cost, scale, presentation of information, role of participants, and the like. (The assessment is not intended to prescribe specific analytical techniques or to judge the appropriateness of previous major urban transit decisions.) It is anticipated that research tasks to satisfy the general objective will consider, but will not be limited to, the following tasks:

Task 1—Inventory all applicable regulations and requirements concerning the evaluation of proposed major

urban mass transportation investments.

Task 2—Review relevant literature on alternatives analysis and transit investment decision-making.

Task 3—Prepare methodologies for (a) the analysis and assessment of recent alternatives analysis decision-making experiences and (b) the selection of case studies.

Task 4—Select and conduct case studies, including those undertaken pursuant to the 1976 guidelines as well as other cases.

Task 5—Evaluate the usefulness of information developed in alternatives analysis for decision-making at each level of government.

Task 6—Formulate recommendations to Federal DOT and to state and local agencies.

AREA 38: SYSTEM PLANNING

Project 38-1 FY '81

National Transit Computer Software Directory

Research Agency: To Be Determined
Principal Invest.:
Effective Date:
Completion Date:
Funds: \$100,000

Project details will be developed in March 1982.

AREA 39: ROUTE PLANNING

Project 39-1 FY '81

Study of Automatic Passenger Counting System

Research Agency: To Be Determined
Principal Invest.:
Effective Date:
Completion Date:
Funds: \$175,000

Project details will be developed in March 1982.

AREA 40: IMPACT ANALYSIS

Project 40-1 FY '81

Development of a National Standard Analysis Process for Cost Benefit of Transit Systems

Research Agency: To Be Determined
Principal Invest.:
Effective Date:
Completion Date:
Funds: \$150,000

Project details will be developed in March 1982.

AREA 43: TRACK AND ANCILLARY SYSTEMS

Project 43-1 FY '81

Detection of Low Current Short Circuits

Research Agency: To Be Determined
Principal Invest.:
Effective Date:
Completion Date:
Funds: \$100,000

Project details will be developed in March 1982.

AREA 47: GENERAL MATERIALS

Project 47-1 FY '80

Improved Service Life of Urban Transit Coach Brakes

Research Agency: Battelle Memorial Institute
Principal Invest.: Dr. Thomas A. Dow
Effective Date: December 1, 1981
Completion Date: November 30, 1983
Funds: \$300,000

The operation and maintenance history of advanced design urban transit coaches shows a dramatic decline in brake life compared with early "new look" coaches. Major factors associated with this decline in brake life appear to be, but are not limited to: increased gross vehicle weight, increased operating speed, body configuration, and changed regulations.

The resultant increased brake temperatures are believed to be the cause of reduced brake life that has increased operational costs to unacceptable levels. Therefore, the need exists to identify and develop methods to increase brake life to previous levels.

The overall project objective is to develop methodologies for improving existing and future urban transit coach brake life. This will include quantification of in-service brake operating temperatures plus identification of methods of reducing brake operating temperatures and/or alternate friction materials.

The project objective will be accomplished in two phases. Phase I will include the following tasks:

Task 1—Confirmation of the premise that temperature is the cause of reduced brake life by the collection and evaluation of brake operating temperatures. This is to be accomplished in cooperation with a major metropolitan transit operator that has experienced the problem. As a minimum, temperature levels will be established for advanced design and early "new look" transit coaches.

Task 2—Development of practical methods for reduction of operating temperatures and/or identification of friction materials for compatibility with the service temperatures determined in Task 1. The following factors must be considered: (a) adaptability to coaches in service, (b) initial and operating costs, (c) regulations, (d) serviceability, (e) reliability, (f) public acceptability, and (g) feasibility.

Task 3—Cost-benefit prioritization of methods for increasing brake life based on Tasks 1 and 2.

Task 4—Preparation of an interim report with recommendations for implementation of Phase II demonstration.

The Phase II effort will include:

Task 5—Demonstration of one or more suggested corrective methods based on selection by the panel from those recommended in Phase I. This will be accomplished in cooperation with a major metropolitan transit operator.

Task 6—Preparation and submittal of the final report.

Research is under way on Phase I of the study. The Southern California Rapid Transit District of the Los Angeles area has been selected for the conduct of Task 1.

Arrangements are being made for instrumenting four types of buses for collection of brake temperature data.

AREA 54: ENERGY EFFICIENCY

Project 54-1 FY '80

Improve Transit Bus Energy Efficiency and Productivity

Research Agency: Booz, Allen & Hamilton, Inc.
Principal Invest.: Archie M. Riviera
Effective Date: October 1, 1981
Completion Date: April 30, 1982
Funds: \$39,993

Because of rapidly rising fuel prices and uncertain fuel availability, there is a critical need in the transit industry to improve energy efficiency. However, as a result of governmental regulation and other factors, the recent trend in bus technology has actually been toward poorer efficiency. For example, the Advanced Design Buses introduced in recent years require more energy than the buses replaced and, compounding the problem, also have fewer seats. Energy efficiency losses are due to many causes including requirements to satisfy environmental considerations, safety, styling, accessibility, and the like.

Transit operators need to become more aware of the inherent relationships between energy efficiencies and other objectives, such as low initial bus cost and passenger comfort. To promote this awareness, the specific tradeoffs involved in the decision to purchase a particular bus need to be identified and documented in guidelines directed to transit property managers.

The objective of this research is to develop guidelines for transit property managers to follow in specifying a new bus. The guidelines will focus on the energy efficiency and productivity of different bus types, equipment, and options; and be applicable to properties of all sizes and geographic locations.

The researchers have cataloged the basic types of equipment and options available in 35-ft, 40-ft, and articulated transit buses. The equipment and options of interest include power train features (e.g., transmission shift schedule and converters, axle gear ratios, engine size and power rating); special equipment (e.g., wheelchair lifts, kneeling capability); standard component options (e.g., type of heating/air conditioning systems, tire size and type, lighting and other hotel loads); basic design and safety features (e.g., overall weight, seating plan, safety bumpers); and environmental controls (e.g., air pollution and noise).

Estimates of the relative energy consumption levels of the various items of equipment and options are now being developed. For such bus type and size, a baseline equipment configuration will be specified and the energy-consumption characteristics of each option will be related to the baseline. An approach will be developed for estimating energy-efficiency characteristics of buses over the full range of operating environments (e.g., terrain, altitude, climate, maximum operating speed, number of stops per mile).

This approach will specifically address (1) the interrelationship of components and combination of components (e.g., axle ratio vs. engine rating vs. transmission shift points); and (2) the tradeoffs between energy efficiency and speed, acceleration, passenger comfort, etc.

The final product of this research will be a concise set of guidelines for use by managers of individual transit properties in selecting and specifying buses for purchase. The guidelines will be designed for immediate use and be capable of being updated as additional information is developed by individual properties and manufacturers and/or through further research.

Project 54-2 FY '80

Energy Management of Electric Rail Transit Systems

Research Agency: Carnegie-Mellon University
Principal Invest.: Dr. Richard A. Uher
Effective Date: October 1, 1981
Completion Date: December 31, 1982
Funds: \$135,115

Rapidly increasing electric energy costs have resulted in a dramatic increase in operating expenses of transit authorities operating electric rail systems. This problem is further augmented by additional increases in rates being sought by electric utilities. The peak demand component of these rates is directly associated with the electric energy generation, transmission, and distribution facilities cost. As major electric energy consumers, transit authorities are subject to allocated costs associated with these facilities. If transit authorities can improve the management of peak demand on their systems, energy costs can be significantly reduced. Several transit authorities have developed strategies for: reducing peak energy consumption (such as load management), improving vehicle energy efficiency, and more energy efficient operating practices.

The objective of this research is to provide guidelines for transit authorities to lower peak electric demand and, thereby, lower costs. It is anticipated that the proposed study will include but not be limited to:

1. Identification of the contributing factors that cause peak demand and the timing and significance of each.
2. Identification of monitoring strategies and conservation opportunities in order to be able to control peak demand.
3. Identification and evaluation of various load management techniques and their cost/benefits and effectiveness on reducing peak demand.
4. Development of strategies so that the benefits of peak demand management are reflected in rates.

It is intended that the research will result in the development of methodologies for: (1) forecasting the peak electric energy demand, (2) monitoring the actual demand, and (3) controlling the demand. It is also intended that a

preliminary plan will be prepared for validating and demonstrating the developed methodologies.

Research is under way on Tasks 1 and 2 involving the collection of data from four transit properties. The transportation system energy management model previously developed by Carnegie-Mellon University will be utilized during the study.

AREA 60: SPECIAL PROJECTS

Project 60-1 FY '80

Synthesis of Information Related to Transit Problems

Research Agency: Transportation Research Board
Principal Invest.: Dr. Paul E. Irick
 Thomas L. Copas
Effective Date: November 7, 1980
Completion Date: Continuing
Funds: \$210,000

Transit administrators, engineers, and researchers are continually faced with problems on which much information exists either in documented form or in terms of undocumented experience and practice. Unfortunately this information is often fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may be unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

In this project, particular transit problems, or sets of closely related problems, will be selected by the NCTRP Technical Steering Group as topics for information synthesis.

For each topic the objectives are:

1. To locate and assemble documented information.
2. To learn what engineering practice has been used for solving or alleviating the problem.
3. To identify all ongoing research.
4. To learn what problems remain largely unsolved.
5. To organize, evaluate, synthesize, and document the useful information that is acquired.
6. To evaluate the effectiveness of the synthesis after it has been in the hands of its users for a period of time.

Through December 1981, research has been completed on the first two assigned topics: TS-1, "Cleaning Equipment and Procedures for Transit Buses"; and TS-2, "Priority Treatment for Buses on Urban Streets." These synthesis reports are in the NCTRP editorial and publication process. Project details will be developed in early 1982 for the following topics: TS-3, "Cost-Benefit Analysis of Fuel Additives and Alternative Fuel Grades"; and TS-4, "Standard for Allocation of Time for Maintenance Workers."

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